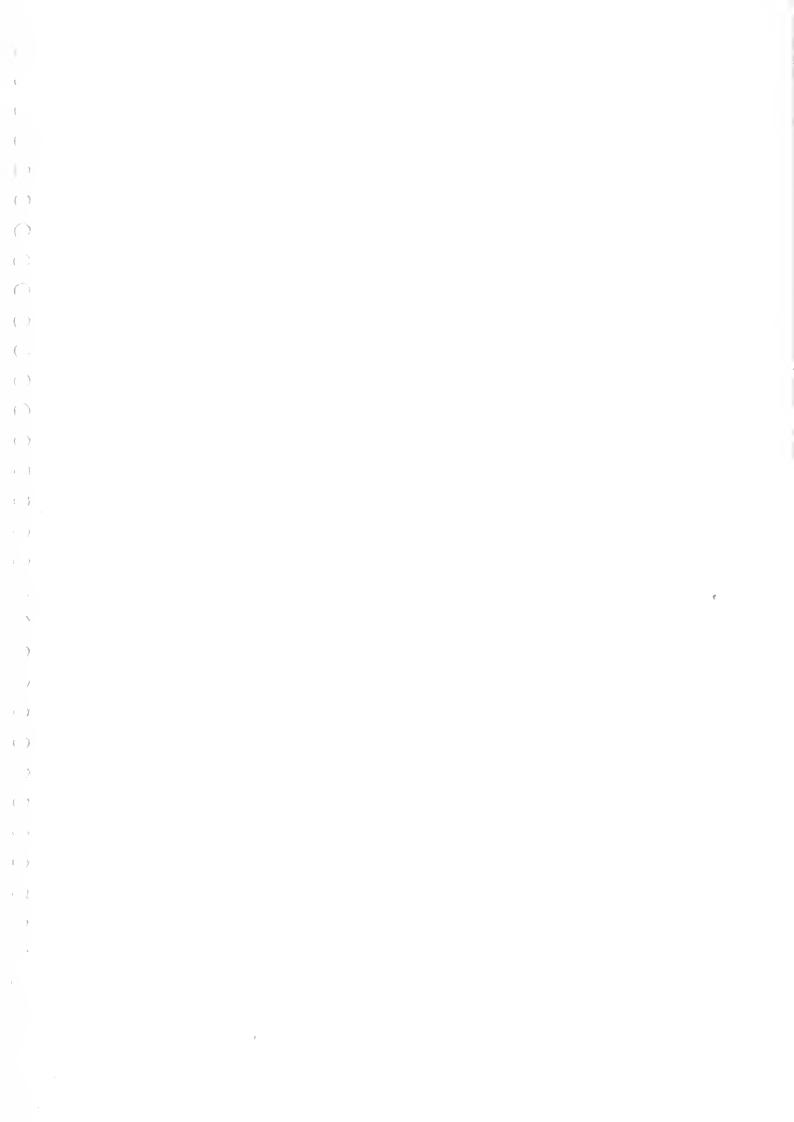
Welding Codes & Standards

Lecture (hrs.)	Topic	Sr. No.
3.00	Sec-IIA (Materials)	ŀ
3.00	(slainateM gnibleW) Oll-seS EMSA	2
00.8	ASME Sec IX - WPQ	8
00.8	ASME Sec IX - WPS/ PQR	Þ
00.7	ASME Sec VIII Div.1- Manufacturing	S
00.8	- gni1utɔstunsM -S.viO ⊞V ɔə≳ ∃M≳A	9
00.8	elanucturals - 1.11 - SWA	L
3.00	gniqi9 - 8.18 8 3MSA	8





HAZIRA Heavy Engineering Division Heavy Engineering Division

Training Material for Welding Technology
Programme for M.E. Students of
The Maharaja Sayajirao University of BarodaVarodara, sponsored by L&T.

VALUE SEC. II-A - MATERIALS

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Section-IIA Pressure Vessels Code ASME Boiler And

By Allwyn Lewis

Contents



- Overview of various sections of ASME codes
- Material selection criteria.
- ASME Section II
- ASME Section IIA-Fettous material specification
- Types of materials
- . A numpers
- Specification for Carbon steel plate-SA 516/SA 516M
- Specification for Carbon steel forging

VESSEL CODES VSWE BOILER AND PRESSURE



Radioactive Material and waste	
Packaging of spent Nuclear Fuel and High level	
Appendices Division 3 Containment Systems for Storage and Transport	III
Sub Section CC Concrete Containments	
Division 2 Code for Concrete Reactor Vessels and Containments	III
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Subsection MCA General Requirements for Division 1 & Division 2	III ′
Part A Ferrous Material Specification Part B Mon Ferrous Material Specification Part D Properties (US Customary) Part D Properties (Metrics)	
$N_{ m faterials}$	II
CTIONS Rules for Construction of Power Boilers	I SE

VESSEL CODES VESSEL CODES



IIX

Rules for In-service Inspection of Muclear Power Plant Composers	IX
Fiber-Reinforced Plastic Pressure Vessels	X
Welding and Brazing Qualifications	XI
Division 3 Alternative Rules for Construction of High Pressure	
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cuon of Pressure Vessels	Construc
Recommended Guidelines for Care of Power Boilers VIII Rules for	$\Pi \Lambda$
Recommended Rules for Care and operation of heating Boilers	$L\lambda$
Nondestructive Examination	1
Rules for Construction of Heating Boilers	ΛI
	SECLIC

Rules for Construction and Continued Service of Transport Tanks

7

Addenda & Interpretations



- Colored sheet addenda-Includes addition & revisions to
- eboo lo snottose laubivibai
- Published annually
- Sent automatically-Up to 2007 code publication
- Edition and addenda in loose leaf format
- As on today
- Edition 2004 & addenda 2006

 For interpretation of technical aspects —ASME issues written
- replies as interpretations issued annually (July) with Edition/Addenda



Code Cases



- In urgent need & when rules for materials/construction not
- Böller and pressure vessel committee considers proposed addition and revision of codes & to formulate cases
- Adopted code case appears -2004 code case book
- (2) Mucleat components

(1) Boiler and pressure vessels

Material Selection Criteria



- Service media
- Corrosive-sea water, urea
- H₂, H₂S, Ammonia
- Temperature
- Cryogenic
- Medium temperature - Low temperature
- High temperature
- Pressure
- High pressure Q & T material - Low pressure

Material Selection Criteria



- > Standard
- Additional requirements - Material specification
- $\triangleright \text{ Economy}$
- Cost
- Weldability - Availability
- Manufacturability

ASME Section II -Materials



- Part A Ferrous material specifications
- → Part B Non ferrous material specifications
- Part C Specifications for welding rods,
- electrodes, and filler metals.
- Y Part D Properties (customary)
- Properties (metric)

Section II Part A Ferrous Material Specification



Lypes

- Steel plates, sheets and strips for pressure vessels
- > Steel pipes
- Steel tubes
- > Steel flanges & fittings > Structural Steel
- > Steel bars
- > Steel Bolting materials
- sgnigioi ləsi∂ ∢
- Corrosion-resisting and Heat-resisting steels

Steel Plates



General Requirements for Steel plates for	02-A2	4
$_{ m b}$ rcss $_{ m L}$ css $_{ m c}$ rcss $_{ m$		
Pressure Vessel Plates, Alloy steel, Mickel	SA-203	<
Pressure Vessel plates, Alloy steel, Molybdenum	5A-204	<
Chromium and Chromium-Nickel Stainless	042-A2	∢
steel Plate, for Pressure vessel	SA-263	<
Corrosion-Resisting chromium steel-clad plate	497-VS	< .
Stainless Chromium-Nickel-Steel Clad Plate	SA-265	₹.
Nickel and Nickel- Base Alloy Clad Steel Plate	S82-A8	≪ .
Pressure Vessel Plates, Carbon Steel	SA-302	∢ .
Pressure Vessel Plates, Alloy Steel, Manganese-	700-170	
Pressure Vessel Plates, Alloy Steel, Chromium-	78 E-A S	<
Molybdenum		

Steel Plates



General Requirements for Flat-Rolled Stainless Steel Plate	084-A8	<
Pressure vessel Plates, Carbon Steel, for Intermediate and Higher Temperature Service	Sta-A2	4
Pressure Vessel Plates, Carbon Steel, for Moderate and lower Temperature Service	912-A2	<
Pressure Vessel Plates, Alloy Steel, High Strength, Quenched and Tempered	TIZ-A2	<
Pressure Vessel Plates, Alloy Steel, Quenched And Tempered, Manganese-Silicon Steel	EEZ-AZ	<
Pressure Vessel Plates, Heat Treated, Carbon-	788-A2	<
Manganese-Silicon Steel Pressure Vessel Plates, Alloy steel, quenched and Tempered, Chromium-Molybdenum	242-A2	4

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Steel Pipes



Steel Pipe		
General requirements for alloy and Stainless	666-∀S	⋖
Temperature Service		
Seamless ferritic Alloy Steel Pipe for High	355-A2	4
Temperature Service		
Seamless and Welded Steel Pipe for Low-	£££-A2	<
Steel Pipes		
Seamless and Welded Austenitic Stainless	SA-312	4
Temperature		
Seamless Carbon Steel Pipe for High	901-A2	⋖

Steel Tubes



Austenitic Alloy Steel, and Stainless Steel Tubes.		
General Requirements for Ferritic Alloy, and	9101-A2	⋖
and Austenitic Alloy Steel Tubes.		
General requirements for Carbon, Ferritic Alloy,	02₽-450	<
Boilet, Supetheater, and Heat Exchanger Tubes		
Seamless Perritic and Austenitic Alloy-Steel	SIZ-AS	⋖
Exchanger and condenser Tubes		
Seamless Cold-Drawn low-carbon steel Heat	641-A2	⋖

Steel Flanges and Fittings



Forged Fittings		
Common Requirements for Steel Flanges,	196-VS	٠,
Piping Fittings		
Common Requirements for Wrought Steel	004-770	
Alloy Steel for low-Temperature Service	096-AS	
Allow Steel for land managers and Active Steel and		
Piping Fittings of Wrought Carbon Steel and	8A-420	٦.
Wrought austenitic Stainless Steel Piquing Fittings	504-A2	<
Components	-	
Notch Toughness Testing for Piping		
Carbon and Low-Alloy Steel Forgings, Requiring	05E-AS	- 2
Moderate and high-Temperature Service	012 43	
Piping Fittings of cathon Steel and Alloy for	£07-\$10	,
Forged Fittings, for High-Temperature Service	\$62-A2	₹.
Forgeth Fittings for Holdings and against the sound		
Forged or Rolled Alloy-Steel Pipe Flanges,	281-A2	4
aniqi¶		
Carbon Steel Forgings, for General-Purpose	181-A2	4
Carbon Steel Forgings, for Piping Applications	SOL-AS	4
	202 75	

Structural Steel



•		
steel Plate		
Low and intermediate Tensile Strength carbon	582-A2	⋖
Carbon Structural Steel	9 £- ¥S	<
Steel Bars, Plates, Shapes and Sheet Piling		
General Requirements for Rolled Structural	9-VS	4

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Steel Bolting



Fastener Materials or Both, Intended for Use at any temperature from Cryogenic to the Creep Range		
Temperature Service Common Requirements for Steel Fasteners or	796 - VS	4
Pressure and High Temperature Service Alloy steel Bolting Materials for Low-	SA-320	<
for High -Temperature Service Carbon and alloy Steel Muts for Bolts for High-	761-A2	<
Alloy Steet and Stainless Steel Bolting Material	£91-A2	∢

Steel Forgings



Steel Forgings, General Requirements	887-A2	4 %
Steel Forgings for Pressure Vessel Components		
Quenched and Tempered Carbon and Alloy	142-A2	₹
Aessels		
Carbon and Alloy Steel Forgings for Pressure		
Quenched and Tempered Vacuum-Treated	802-VS	. 4
components	٠	
Notch Toughness Testing for Piping		
Carbon and Low-Alloy Steel Forgings, Requiring	026-A2	4
Temperature Parts		
Alloy Steel Forgings for Pressure and High-	99 E- VS	4
Components		
Carbon Steel Forgings, for Pressure Vessel	99 Z- VS	4.
Piping	,,,,,	
Carbon Steel Forgings, for General Purpose	181-A2	4
Carbon Steel Forgings, for Piping Applications	901-VS	4
in the first day of the day of the day	200 10	

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284-A35 88£-A2 testing of Steel Products 078-A2

Straight-beam ultrasonic Examination of Steel

LLS-VS

872-A2

and clad steel plates for special applications.

6d # Id

DIEEEERLA PUUMBERS

ISY-AS

chemical analysis of Steel Products

Test methods, practices and terminology for

Ultrasonic Examination of austenitic steel St6-VS

Straight beam ultrasonic Examination of Plain

Ultrasonic angle beam examination of Steel

Ultrasonic Examination of heavy steel Forgings

Test methods and definitions for mechanical

Forgings

Magnetic Particle Examination of Steel SY2-AS

Testing Methods



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Id	1	2V 102	CI 10	CS Forging CA CA Forging
Id	Į.	641 AS		CS Tube
Id	ī	S82 VS	C\B	CS Plate
ГЧ	ī I	SA 234	WPC	CS Pipe Fitting CS Pipe Fitting
ld	Į ,	EEEAS EEE AS	01 9	CS – Pipe CS – Pipe
Id	1	901 AS	C V\B	CS - Pipe CS - Pipe
Id	ح 1	912 A2 \ 212 A2	0 <i>L</i> 09	CS - Plate CS - Plate
oN -9	Group No	Mat. Spec.	Grade	Met. Quality & Form

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C-0.5 Mo - Forging	FI	282 AS	7	£q
oduT -, oM &.0 - D	TI, Tia, Tib	2V 709	ī	£q
516F4 ~ OM & O – D	TP- B, Cl- 1 or 2	eee as	٤	. £q
əqi4 – oM 2.0 – D	24 / 14	SEE VS	ī	٤ď
91af4 – oM 2.0 – nM	B'C'D	20£ A2	ε	
Mn - 0.5 Mo - Plate	. A	20£ A2	. 5 .	٤d
Met. Quality & Form	Grade	Mat. Spec.	quo1Đ oM	οN -

1.25 Cr – 0M č.0 – 17 č.1	\2\in\1,1 \2\	988 A2		
1. Cr - 0.5 Mo - Forging	F12, CL-1 / 2	282 AS	I I	þd
1.25 Ct. 0.5 Mo – Tube	2 \ I - TT	824 A2	7	₽ď
1Cr (1.25 Cr) – 0.5 Mo – Pipe	119 \ 219	SEE AS	Ţ	þd
1.25 Cr. 0.5 Mo – Plate	11, CI –1 / 2	78£ A2	ξ	
1Cr. 0.5 Mo - Plate	12, Cl –1 / 2	78£ A.≳	I	þd
Met. Quality & Form	Grade	Mat. Spec.	Group No	οN -0

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P5A/B/C



			T -	
2. 25 Ct - 1 Mo - Forging	E55° CI =1 \ 3	988 AS	Ţ	PSA
2. 25 Cr - 1 Mo,V - Forging	F22V	SA 182	ī	D2C
5 Cr - 0.5 Mo - Forging	5H	SA 182	T T	PSB
225 Cr. 1 Mo - Tube	T.P 22	S12 A2	Ţ	PSA
2. 25 Cr. 1 Mo - Pipe	P22	SEE AS	I	v VSd
5 Cr. 0.5 Mo - Plates	2°CI-5	78£ A2	ī	BSG
2. 25 Cr. 1 Mo - Plate	22, CI-1 / 2	78£ A2	. 1	¥\$d
Met Quality & Form	Grade	Mat. Spec.	Group No	oN -q

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Met. Quality & Form	Grade	Mat. Spec.	Group	oN -c
15Cr Plate	TP 429	SA 240	7	9d
13Cr., 4.5 Ni, Mo - Pipe	241500	187 A2	Þ	9.1
13Cr. – Tube	TP410	892 VS	I.	94
13Gr Forging	9년	988 AS	3	9d
17Cr Forging	0£450	SA182	٥	4d
17Cr Plate	TP 430	0+2 VS	7	LΔ
17Cr. Tube	TP430	897 VS	7.	<i>L</i> d
əqi4 – iT , 1381	TP439	IET AR	7	Ld

8**d**



Met. Quality & Form	Grade	Mat. Spec.	oN q	oN -
18Cr., 10Ni, Ti - Pipe	TP321	21£ A2	1	
18Cr., 10Ni, Cb - Pipe	7459T	SA 312	E	84
18Cr., 8 Ni, 2Mo -Forging	31£TT	9££A2	Į.	
25Cr., 20 Ni, Forging	TP310	98€ ∀ S	ı	P8
18Cr, 8Ni - Piates	P304	SA 240	I	
23Cr. 12Cr Plates	TP309S	707 VS	7	84
18C1, 13Ni, 3Mo -Tube	TP317	SA 249	L	
16Cr, 12Ni, 2Mo - Tube	TP316L	SY 249	I	84

/

P9AB

3.3Mi Plate	E	SA 203	1	B64
2.5Ni Plate	Y	SA 203	. I	V6d
3.5Ni Forging	LF3	056 AS	,	P9B
gnigso A - iV & . 1	TE2° CF 5	02£ AS	1	P9A
əduT - iMč.S		\$££A2	1	F94
3.5Mi - Pipe	٤	EEE AZ	Į.	B64
Met. Quality & Form	Grade	Mat. Spec.	ом д	oN -0

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Specification for Pressure Vessel Plates, Carbon Steel, For Moderate and Low Temperature Service (SA-516/SA-516M)

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notch toughness Rathon steel plates - Welded pressure vessels with improved

Tensile Strength Ksi (MPa) Grade U.S.(SI) Crades under this specification:

(054) 59 (585-024) 58-59 (055-514) 08-09 (514) 09 (08ξ) 55 (312-085) 57-55

■ Maximum thickness of the plates furnished (To meet specified (029-584) 06-07 (485)

mechanical property requirements)

(085) 55(305) 21 Maximum thickness, in. (mm) Grade U.S.(SI)

(584) 07 $(502) \cdot 8$ (054) 59 (502) 8 (202) 8 (514) 09

General Requirements



Marking, loading etc. Quality and repair of defects Permissible variation in dimensions and mass Testing and retesting methods and procedures ■ Material specification confirming to SA 20 \ SA 20M outlining

■ Establishes rules for ordering information

Additional Requirements - Supplementary Requirements

Vacuum Treatment

Additional tension testing

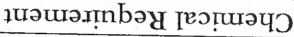
Impact testing

■ In case of conflict with SA 20/SA 20M - Requirement of this Non destructive examination

Manufacture & Heat Treatment



- Steel making practice
- Killed steel
- Heat treatment conditions as per thickness Fine austenitic grain size-As per SA 20/SA 20M
- $<40~\mathrm{mm}-\mathrm{As}$ rolled condition/Normalized or stress relieved or
- both (without notch toughness requirements)
- < 40 mm Normalized (with notch toughness requirements)
- improvement Provided plates are tempered (595 705°C) ■ Faster cooling rates are permissible — For toughness > 40 mm - Normalized





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	<i>ye</i> 0	\$ G. Y	91°0	School, Prack ² : If in, 112.5 med and proder
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02-1-5970	85. \$-28.0	05.1-23.0	0E.E-22.0	Maylana lauborg
06,1-91,0	05,1-97,0	d€_1-97.0 250.0	950'0	inesphalis, max
950-0	550%	\$£0°0	SEO O	
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6.4.2.2	# 1 3 F M	08 15-25 0	01/0-81/0	i certain and
04.0-21.0 25.0-21.0	\$7'0-£1'0 01'0-51'0	56'0-€1'6 06'0-£1'6	\$\$'Q-E\$'8	संस्कृतियम् जातान



Mechanical Requirements

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TABLE 2

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(284) 01	(051149	PD (432)	1086) 55	
70-501 04-07 36 (365) 86 411 152	524 164 32 (560) 72-62 (420-202)	52, 33 [550] 96-80 (472-220)	[232-085] <u>0</u> 7-65 [202] 02 ^A 62 ^A 12	(4914) izk procest alize (4914) izk alien alizenteta izkon jaren 1831, izk alizenteta izkon in 2. izk 1831 izkenen izkon in 2. izkon 1831 izkenen

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Other Supplementary Requirements



■ Bend test

■ Magnetic particle examination

■ High-Temperature tension test Charpy V-notch impact test

Simulated PWHT of mechanical test coupons

■ Ultrasonic examination

Additional tension test

 Product analysis ■ Vacuum treatment



Specification for Carbon Steel Forgings for Piping Applications (M201-A2\201-A2)

Scope



- For ambient & high temperature service-Pressure systems
- Forging includes flanges, fittings and valves
- Maximum weight of forging -4540 Kg
- > 4240 kg-Order as per SA 266
- Tube sheet-Not included in this scope
- When specified by the purchaser



Ordering Information

Purchase order should include as a minimum

Quantity

Additional requirements Supplementary requirements Specification number Size & dimensions



Materials and Manufacture.

Open hearth furnace Method of steel making

■ Sufficient discard-Avoiding injurious piping & undue segregation Fully killed Steel

Electric furnace

Basic oxygen furnace

Material forged - To specified shape and size

■ For hollow cylindrical part machined from hot rolled bar-Axial

length to be parallel to metal flow line of the stock



Heat Treatment

■ Not a mandatory requirement except for

Flanges above class 300

Special design flanges-exceeding pressure temperature rating

of class 300

Piping component-Over NPS 4 & above class 300 $\,$ Flanges - Unknown design temperature or pressure

Applicable Heat treatment are

Annealing

gnizilennoV

Quenching and tempering Normalizing and tempering

Annealing



temperature below 538°C ■ Immediately after forging operation Cool the forging -

A group of forging re-heated represents-Annealing charge \blacksquare Re-heat to a temperature 843 - 927°C - to refine the grain

■ Uniformly cool in the furnace

gnizilsm10N

- Immediately after forging operation Cool the forging -
- \blacksquare . Re-heat to a temperature 843 927°C to refine the grain temperature below $538^{\circ}C$
- Uniformly cool in the air A group of forging re-heated represents-Normalizing charge

Tempering



■ Tempering time-0.5hr/in (min) of maximum section thickness temperature ■ Tempering temperature-593°C to lower transformation



Quenching

- Forging fully austenetized ■ First procedure
- Multiple stage procedure Quenched in switable liquid medium
- Re-heat to partially reaustenetize Rapidly cooled Forging fully austenetized
- All quenched forgings to be tempered Quenching in suitable liquid medium

Chemical Composition



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Semposition, %	memet.	
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80.1-64.0	SSTUBEROOM	
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General Mules—For each redoctator at 0.01% below the specified carbon maximum (0.35%), so increase at 0.06 which maximum in 1.05% will be permitted up to a cot qu bastimum in 1.05% will be permitted up to a

\$3.70% (2) The cure of teaper, wherei, circums and molybodenus shall (1) and exceed L.D. 2004. Lead in the cure of the cure of

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Cast or Heat Analysis

■ For analysis -Samples taken during pouring of heat

Composition, %	Element.		
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0.12 may [Hotes (21/22)	रमासम्बद्ध द्वापृ		
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Product Analysis

- For solid forgings-sample taken midway between center and
- For hollow forging-sample taken midway between inner surface
- test specimen

 Sample for analysis can also be taken from broken mechanical

 and outer surface



Product Analysis

TABLE 2 PERMISSIBLE VARIATIONS IN PRODUCT ANALYSIS

F.ni DOOL 1940 (Sins OSE Of)	61 006 vend 8 1516 of 15 mb 055 of 15 mb 15 of	04 (302 1940) 68-52) 2 14 06-8 27-82 05-62 at 12-81	62 625 vev0 68 625 5 mi 004 1 ms 68 25 ot 1 so 7	^{\$} ni 90% (5,000 con 1900 ton	
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\$70°5	850.0	0.00.0	Ø ∉ 0 S	0.030	அவுவ
40.0	SOLIP	₩010	⊅B*Q	50.0	Leaf
E0.0	50'0	€3.4	€0^0	€0.0	+adido
€6.6	EGLO	63.9	20.0	6.0.0	[BY26]
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£6.4	tora	10.0	1373	10.0	ເອງເລລາຄຸນ
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Mechanical Properties

Mechanical requirements inog (I))

NOTES: (1) For establ forgings, see 9.4.8. (2) Contennings by either the 0.2.85 offset method o	-native 48 8,0 3(i) go
*** 'dh 'stanbath	181
Reduction of area, min, % [Note (4)]	Đ€
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Mechanical Properties



- Specimens taken from production forging after heat treatment
- Specimens taken from separately forged test blanks prepared from same stock
- Test blank should have
- Approximately same working as product
- For N, N+T, Q+T- Central axis of test specimen at ¼ T or deeper Heat treatment with finished product
- Tension Test

Same heat treating temperature and furnace with +/- 14° C-equipped More then one heat in a heat treating charge-one test per heat For each heat treating charge-one test For each heat-one test

with recording pyrometers-one tension test per heat

Hardness Test



Minimum of two forgings required to be tested per batch

Repair by Welding



- Repair of defects permissible for forgings made to dimensional standard
- Prior approval of purchaser required-special forgings
- Welding procedure and welder-qualified as per ASME sec. IX
- Welding process with high level of hydrogen-not permissible
- Before welding-MT of ground area
- Forgings repair welding-to be PWHT
- Without prior approval of purchaser-repair shall not exceed

10% of surface area 33% of wall thickness

10 mm, Which ever is lesser



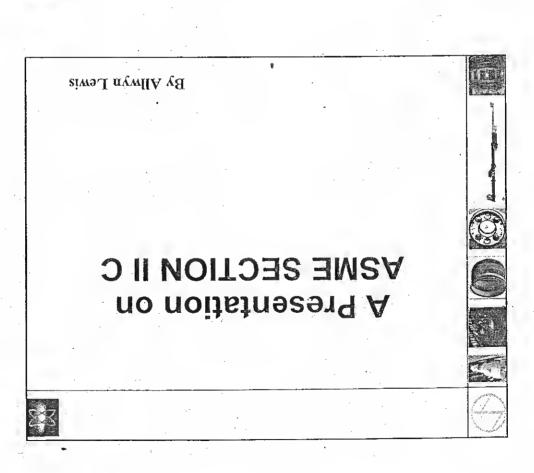
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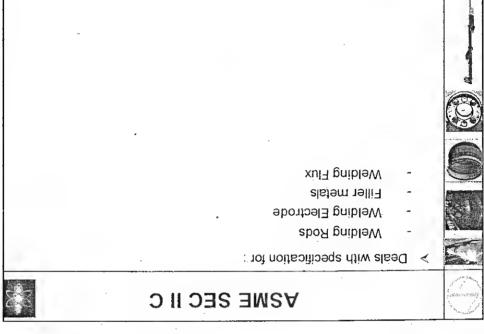
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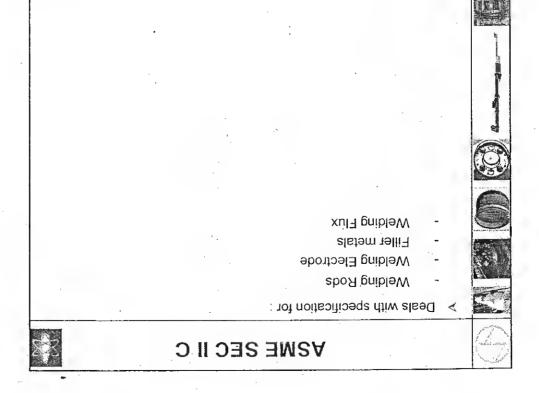
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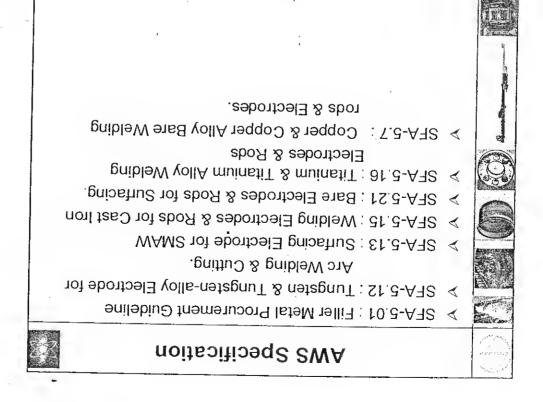


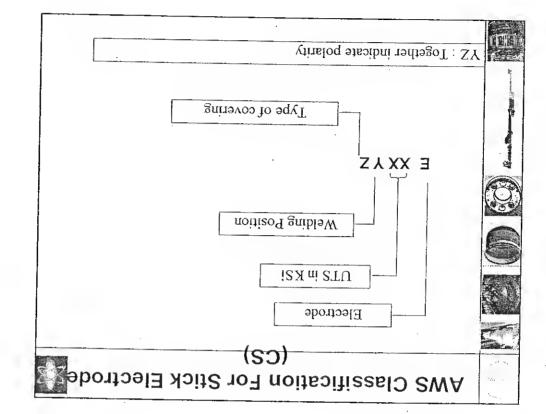






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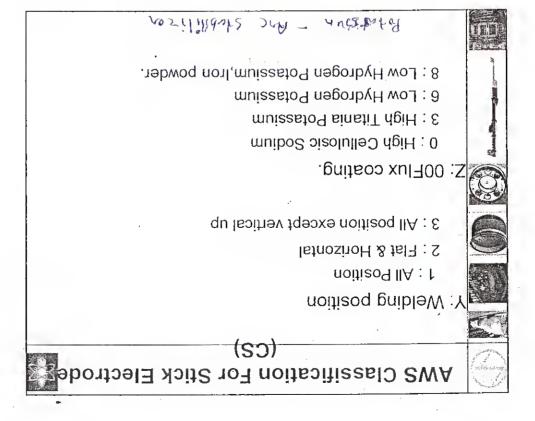


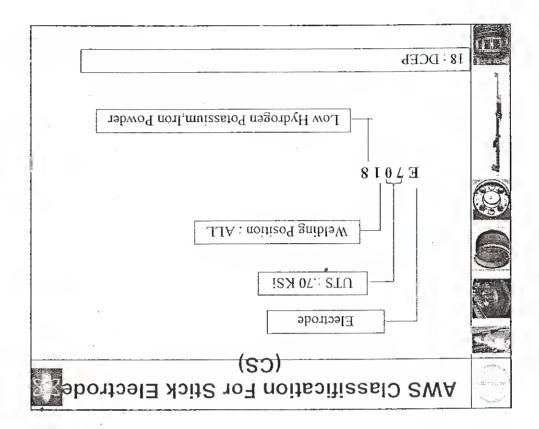


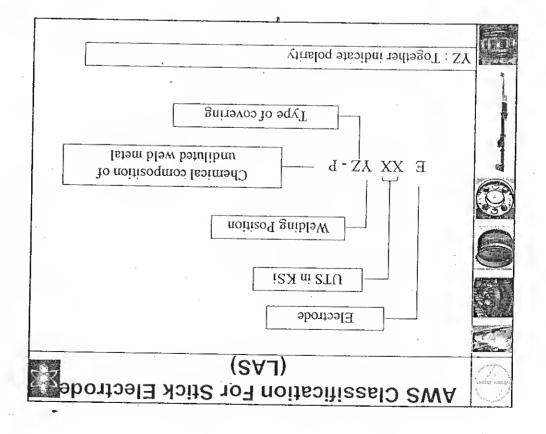
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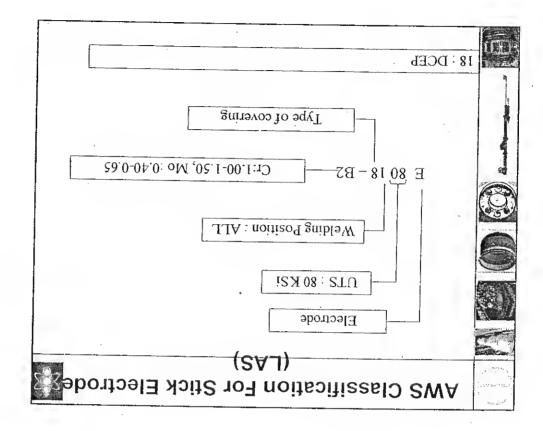
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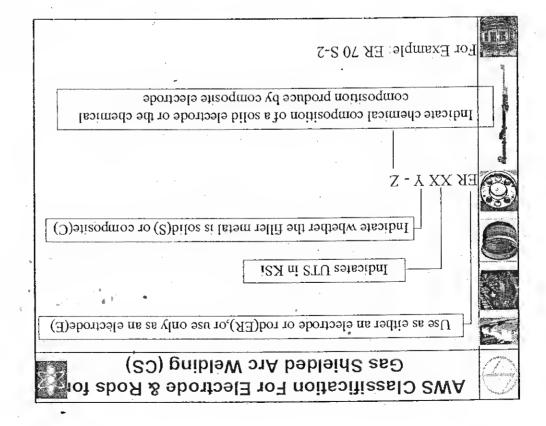
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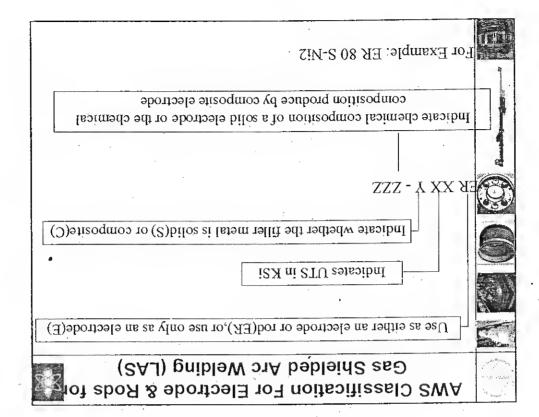
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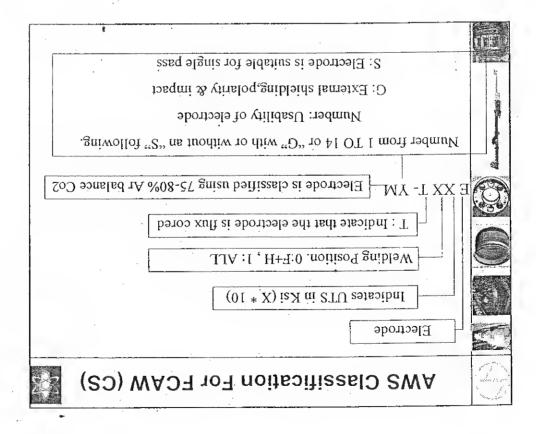
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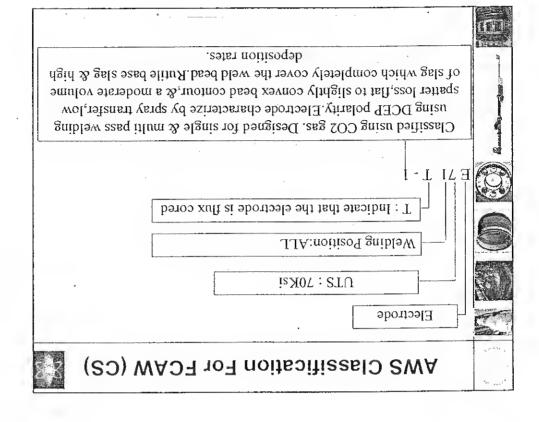
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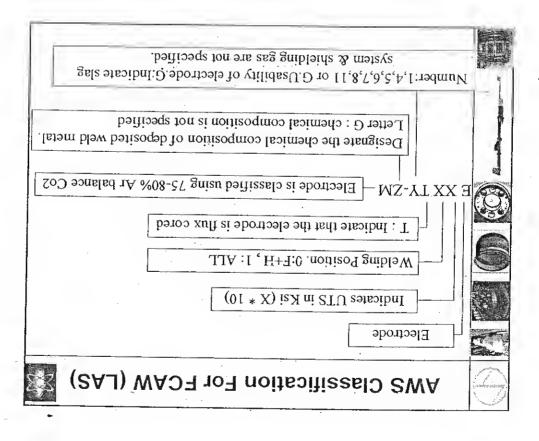
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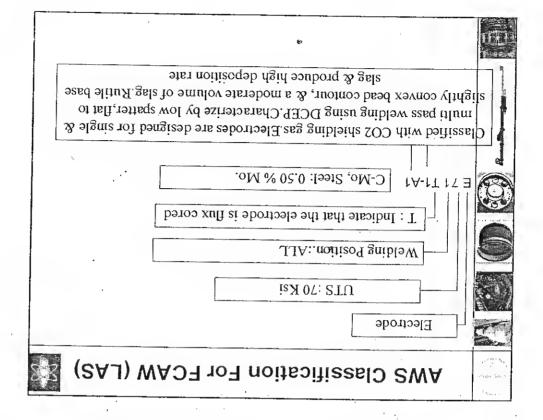


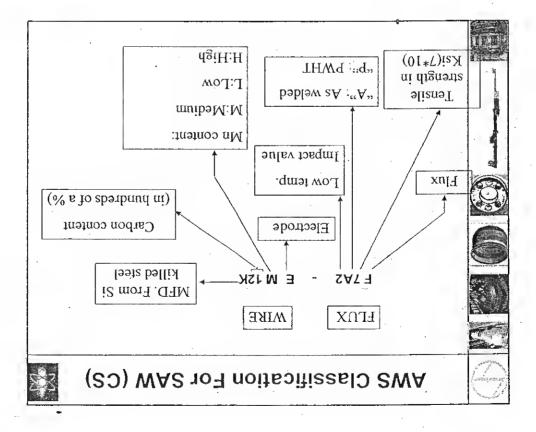


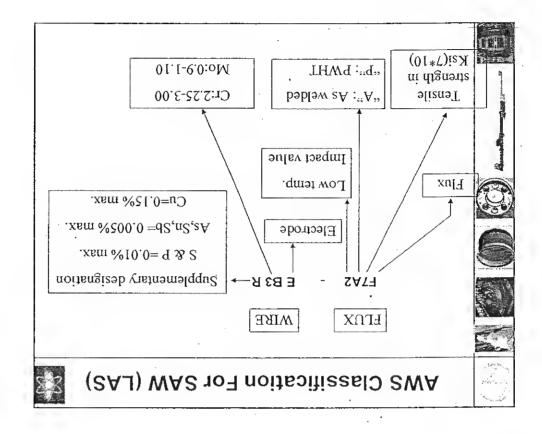


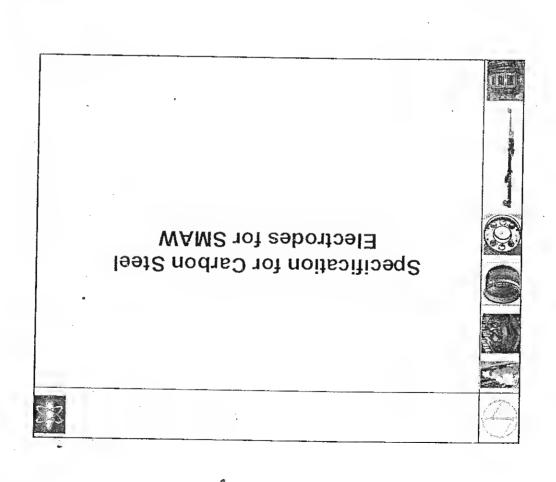


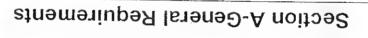












- Classification according to (1)Type of Current
- (2) Type of Covering
- (3) Welding Position
- (4)Mechanical Properties of the weld metal

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Electrode Classification

AC or DCEN DCEN		əbixO	
	H-Fillet,	norl dgiH	Ee050
DCEN PC'DCEЬ ○∟	ь'л'он'н	nonl sinstiTebixo muisstoq	E9016
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AC or DCEN	Е'Л'ОН'Н	sinstiT dgiH muibo2	E9015
AC or DCEP	Н'НО'∧'∃	High Cellulose Potassium	Ee011
DCEP	н ' но'л' э	High Cellulose muiboS	Ee010
Type of Current	Welding Rosition	Type of Covering	AWS Classification
	AC or DCEP AC or DCEN AC,DCEP or AC,DCEP or AC,DCEP or	Ровійол Е,V,ОН,Н АС ог DCЕР Е,V,ОН,Н АС ог DCЕР Е,V,ОН,Н АС,DCЕР ог DCЕИ	Covering Position High Cellulose Potassium High Titania F,V,OH,H AC or DCEP Sodium Sodium High Titania F,V,OH,H AC or DCEN Potassium F,V,OH,H AC,DCEP or Dctassium Potassium F,V,OH,H AC,DCEP or Dctassium Iron F,V,OH,H AC,DCEP or Dctassium Coxide Titania F,V,OH,H AC,DCEP or Dctassium Iron F,V,OH,H AC,DCTASSIUM Iron F,V,OH,H AC,DCTASSIU

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Potassium

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Iron powder

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Iron powder Potassium

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Covering

Type of

Electrode Classification

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Classification

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H-Fillet,

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Е'Л'ОН'Н

Е, У, ОН, Н

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Position

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AC or DCEP

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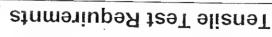
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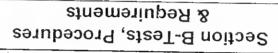


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22	84	09	E6011
۷١.	84	0.9	E6012
	84	09	Ee043
22	84	. 09	E6019
22	84	09	Ee020
	89	07	E7014
22	28	0.2	E7015
22	28	04	E7016
22	89	04	E7018
Z١	28	04	E7024
	89	04	E7028



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Summary of Tests
Chemical Composition
Mechanical Properties
Soundness of Weld Metal
Moisture Content of Low Hydrogen Electrode
Usability of Electrode

Twice Retest allowed Results of both retest-Meeting the Requirements Retest Specimen-Taken from original/new test assembly Chemical analysis-Retest for failed elements only



Weld Test Assemblies

One or more of following Assemblies Required

(1)Weld pad - Chemical analysis of undiluted weld metal

(2) Groove weld-Mechanical properties & Soundness

(3)Fillet Weld for usability of electrode

(4)Groove weld-Transverse tensile & longitudinal bend-

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(5) Groove weld-Mechanical properties & Soundness-



Thank You



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LARSEN & TOUBRO LIMITED HAZIRA HAZIRA

Training Material for Welding Technology
Programme for M.E. Students of
The Maharaja Sayajirao University of BarodaVarodařa, sponsored by L&T.

MEIDING & BRAZING QUALIFICATION
ASME SEC. IX -

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A Presentation

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YZWE SECION IX

By: Hemal Desai

Welding Engineering

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YZWE SECTION IX



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➤ Qualification standards for Welding & Brazing Procedures, Welders, Brazers, & Welding & Brazing Operators.

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YZWE ZECLION IX



Divides into Two Parts: - Part QW-Welding

- Part QB- Brazing

Part QW - Welding

Article I – Welding General Requirements
Article II – Welding Procedure Qualification
Article III – Welding Performance Qualification
Article IV – Welding Data

Welding Qualifications



- · Welding Procedure Qualification
- Welders' or Welding Operators' Performance

WPS & PQR



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To determine that the weldment proposed for construction is capable of having the required properties.

WPS: Welding Procedure Specification

PQR: Procedure Qualification Record

WPS & PQR



- WPS:A written qualified welding procedure prepared to provide direction for making production welds to code requirement
- Contents of WPS: Essential, Non Essential, and, when required Supplementary essential variables for each welding process used in WPS.
- Changes to the WPS: May be made in non essential variables to suit production requirements without requalification.
- Availability of the WPS:WPS used for code production welding shall be available for reference & review by Al at fabrication site.

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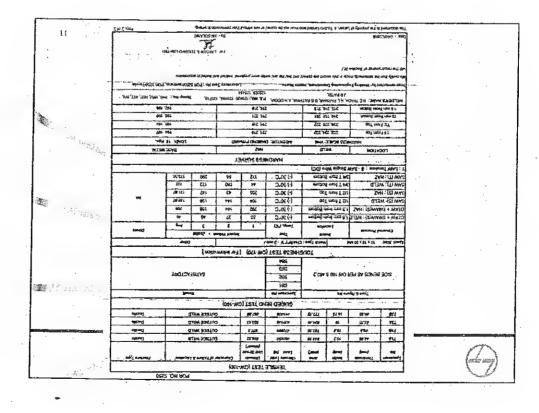
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- PQR: A record of the welding data used to weld a test coupon. Also contain test result of the tested specimen.
- Content of the PQR: PQR shall document all essential &, when required, supplementary essential variables for each process used
- during welding of test coupon. Changes to PQR are permitted except
- Editorial Correction
- Addenda to the PQR
- Additional information can be incorporated in PQR at a later date provided the information is sustained as ahving been the part of the original qualification condition by lab record or similar data.
- Availability of PQR:PQR shall be available upon request for review by AI PQR need not be available to the welder or welding operator.

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WPS & PQR



- WPS $$\operatorname{Multiple}$ WPS with One PQR $\backslash \operatorname{Multiple}$ PQRS With One
- single PQR may be prepared from the data on a
- Single WPS may cover several essential variable casential variable & when required, supplementary essential variable

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Welding Procedure Qualification



- Proves the Quality / Properties of Weld Joint
 Prepared by a set of welding variables
- Welding Process
- Base Material
- Welding consumable
- Welding Parameters & Techniques (Position, Polarity, Preheat, Inter Pass Temp.)
- PWHT etc.
- Qualification limited to the essential variables of the Specific Process

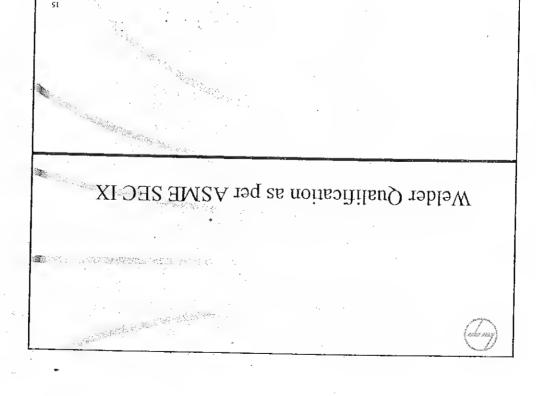
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Welding Procedure Qualification



- MELDING DATA
- A set of Welding Variables involved in Preparing a Weld Joint.
- ESSENTIAL VARIABLE
- A change in welding condition which will affect the mechanical properties (Other than notch toughness) of weld joint
- SUPPLEMENTARY ESSENTIAL VARIABLE
- A change in welding condition which will affect the notch toughness properties of weld joint
- NONESSENTIAL VARIABLE

A Change in welding condition which will not affect the mechanical properties of the weld joint





- Mandatory Requirement from Codes /Standards \
 Regulations
- Qualification Tests in accordance with the Applicable
 Code \ Standards \ Regulation.
- SEC IX
 Secoptance Criteria of Test Results as per ASME
- Qualification Records and Test Results to be

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- Produce defect free/Sound weld Ascertain the skill of a welder or a welding operator to
- Qualified Procedure. Makes A Weld Coupon Using an Approved WPS of a
- Weld Coupon Undergoes Soundness Test
- Welder Number Each Qualified Welder Shall be Assigned by A Unique
- Welders' Qualifications Records Are Documented
- variables of the Specific Process Performance Qualification limited to the essential

How To Qualify A Welder



- Performance Qualifications Understand ASME Sec. IX - Welding
- Variables For Different Processes QW 350
- Limits Of Positions Qualified & Dia AV 461
- Testing Requirements QW 304-1



Important Definitions as per ASME SEC IX

- Welder: One who performs manual or semiautomatic
 welding.
- Welding Operator: One who operates machine or automatic welding equipment.
- Manual Welding: Welding wherein the entire welding operation is performed & controlled by hand

Contd.

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Welding Performance Qualification



- Semiautomatic Welding: Arc welding with equipment which controls only the filler metal feed. The advance of welding is manually controlled.
- Machine Welding:Welding with equipment that has controls that are manually adjusted by the welding operator in response to visual observation of welding.
- Automatic Welding:Welding with equipment which performs the welding operator.

 controls by a welding operator.

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- Backing: A material placed at the root of a weld joint for the purpose of supporting molten weld metal
- Double welded joint: A joint that is welded from both sides.
- Single-welded joint: A joint welded from one side only
- Consumable Insert: Filler metal that is placed at joint rot before welding,& intended to completely fused into the root to become part of the weld.



Welding Performance Qualification

- F-NUMBER: Assign filler wire in order to reducing the welder procedure & performance qualifications. (QW-432)
- P-NUMBER. Assign to base metal in order to reducing the welder procedure qualifications. (QW-420)
- Retainer. Non consumable material, metallic, which is used to contain or shape molten weld metal.



- MELDING DATA
- A set of Welding Variables involved in Performing a Weld Joint.
- ESSENTIAL VARIABLE
- NONE SERVINE VARIABLE
 spility of welder to deposit sound weld metal
- A Change in welding condition which will not affect the ability of welder to deposit sound weld metal

Welding Performance Qualification



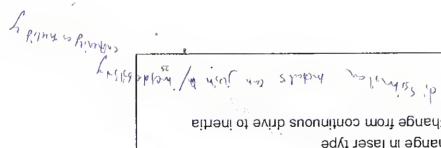
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Essential Variables - Automatic Welding

- · Change from automatic to machine welding
- Change in the welding process
- EBW: Addition or deletion of filler metal
- EBW: Change from vacuum to out of vacuum equip, or
- vice versa.
- Laser welding: Change in laser type
- Friction Welding:Change from continuous drive to inertia
- Or vice versa.



Welding Performance Qualification



Essential Variables - Machine Welding

- Change in the welding process
- & vice-versa Change from direct visual control to remote visual control
- WATO 101 OVA to noiseled
- · Deletion of automatic joint tracking
- Deletion of consumable insert.
- Deletion of backing
- side but not the reverse. Change from single pass per side to multiple passes per



Material Grouping(P-Numbers)

Carolin State	guixerA	gnibls\/	Base Metal
·	P-No. 101 through P-No. 103	P-No. 1 through P- No. 11 incl. P- No. A.A. 5B, and De. OA.	Steel and steel alloys
	P-No. 104 and P-	P-No. 21 through	uls bus munumlA szed-munim syolfs
	P-No. 107 and P-No. 108 108 109 discount of the office of	P-No. 31 through P-No. 35 P-No. 41 through P-No. 47	Copper and cop- per-base alloys Vickel and nickel- base alloys
	P-No, 112 P-No, 115 P-No, 117	P-No. 51 through ¹ , P-No. 53 P-No. 61 through	Titanium and tita- nium-base alloys Zirconium and zir- conium-base
,27		P-No, 62	separation s

Welding Performance Qualification



TopleW not laires Material for Welder world for moissiffication

Qualified Production
Base Metal(s)

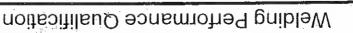
P-No. 1 through P-No. 11, P-No. 34, P-No. 41 through P-No. 34, P-No. 41 through P-No. 34 through P-No. 25 and P-No. 51 through P-No. 53 and P-No. 51 through P-No. 53 and P-No. 51 through P-No. 53 and

Base Metal(s) for Welder Qualification

P-No. 1 through P-No. 11, P-No. 34, or P-No. 41 through P-No. 47

P-No. 21 through P-No. 25 P-No. 51 through P-No. 53 or P-No. 61 through P-No. 62

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QW-423 Alternate F-Numbers for Welder Qualification

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	żх										Е.Мо. s Without Васкінд
	×	X							-		F.No. & With Eacking
			х.								F-No. 4 Without Backing
			X	х							F-No. 4 With Backing
14,					Х						F.Mo. s Without Backing
			х	Х	X	х					F-No. s With Eacking
		-					х				F. No. 2 Without Packing
			x	, X	χ	Х	Х	Х			F-No. 2 With
									х		F. Mo. 1 Without Backing
	х	х	, X	х	X ·	Χ.	х	X	х	X	Backing F-No. 1 With
	Backing	Васклод	Backing	Вијузед	Взский	Вэскид	gmixbed	graphi	Backing	ව්යාදන	Qualified For \$
1	F.No. 5	F-No. 5	F.No. 4	F.No. 4	F.No.3	E.ON-4	F.No. 2	Z ON 1	F.No. 1	F. No. 3	← Ari W berilisu()

Welding Performance Qualification



QW-423 Alternate F-Numbers for Welder Qualification

All F-No. 6 [Note (1)]
EVEN AND A MAKET HEA

noinefileup att gaimb besu Only the same F-Number as was

need during the qualification Only the same F-Number as was 19 'ON-3 HY All F-No, 51 through F-No, 54 through F-No. 45

F-No. 34 and all F-No. 41

Any F-No. 6

E-No. 37 33, F-No, 35, F-No, 36, 01 Any F-No. 31, F-No. 32, F-No. Any F-No. 21 through F-No. 25

dilW bantilanQ

19 ON-H KUV Any E-No. 51 through F-No. 54 through F-No. 45 F-No. 34 or any F-No. 41

Any F-No. 71 through F-No. 72

QW-442 shall be considered to be classified as F-No. 6. SEA Specification but which conforms to an analysis listed in (1) Deposited weld metal made using a bare rod not covered by an

0501-07 25018 brad rathos 14202



		Important F-NUMBERS	
	Lit - Whitehold 5 -		
	uone	Cronping of Electrodes and Weiding Rods for Qualific P-NUMBERS QW-432	
-	AWS Classification	natisoniogga AMZA	.ом-
١.	EXXJ2		р
	EXXI9	1,2-A78	Þ
	EXX18	1.2-472	Þ.
	M8IXX3	5.F.A.7.8	b
	8pXX3	SFA-5.1	t
	EXXX(X)-12	SFA-5.4 Other than auxientic and duplex	4
	EXXX(X)-16	A-5-4 other than austenitic and duplex	b
	\(\frac{1}{2}\)	SFA-5.4 other than austenitic and duplex	t

Qualification	Performance	Welding



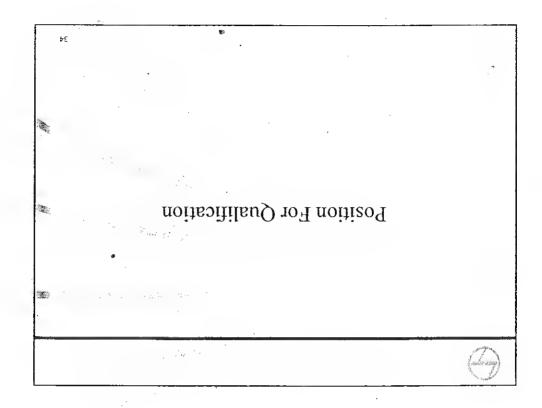
	QW-435 Crouping of Electrodes and Weiding Rods for Qualification		
	AWS Classification	ASME Specification	F-No.
	EXXX(X)·15	SFA 3. Sustenitic and duplex	ş
	EXXX(X)-19	SFA-5.4 austenitic and duplex	ç
			3
	£XXX(X)-11	SFA-5-4 sustenitic and duplex	ç
•	แดกระสาย	Grouping of Esectroses and Welding Rock for Qua	
	AWS Cassification	notendance Stack	F-No.
	E MICTFe-1	. II.2.A32	543
	E-MICHFe-2	[1.e-A72	Etr
	E-931/0/HE-3	[1.2.A42	52
A.C.	₽-3910M3	11.8-A42 11.8-A42	65 65
	E MICTF6-7		εb
	E MICHE-9	££.2-A72	43
	01-94101M3	II,8.A∃2	٤٤
	EMICEMO-3	II.e.A48	٤٤
	E NICKMO-6	SFA:3.1	ξÞ
1	EMICTMO-12	I [, 2, A 42	Eb

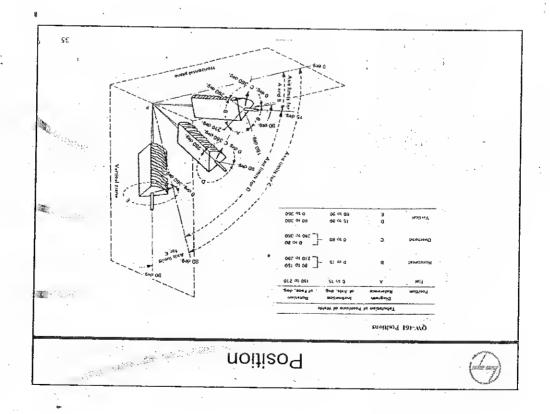
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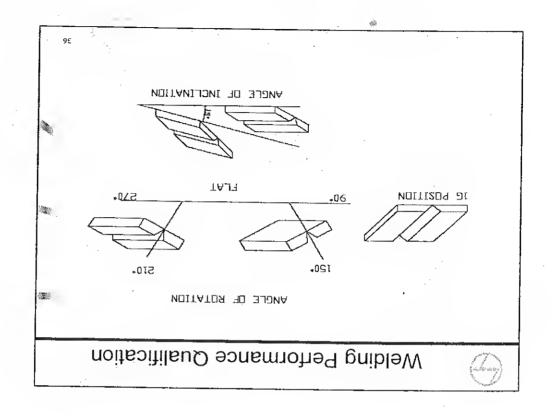
Groove Weld Positions – QW461



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ŝ	Inclination of	Base Metal Position		Groove	St No.

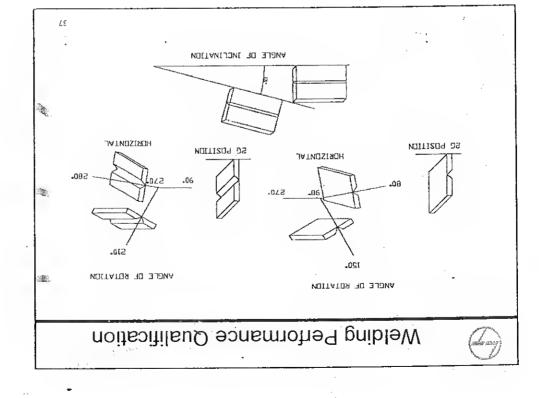


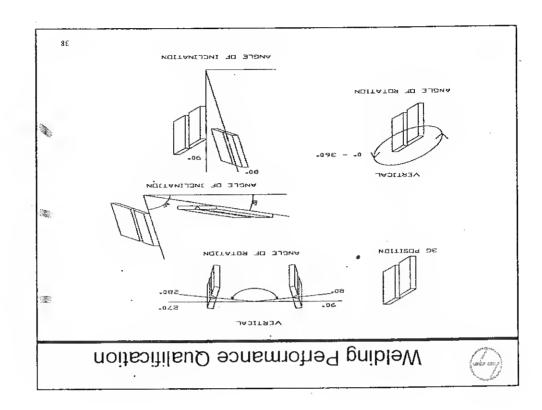


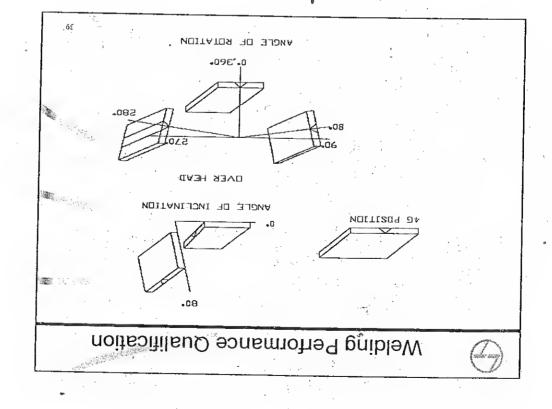


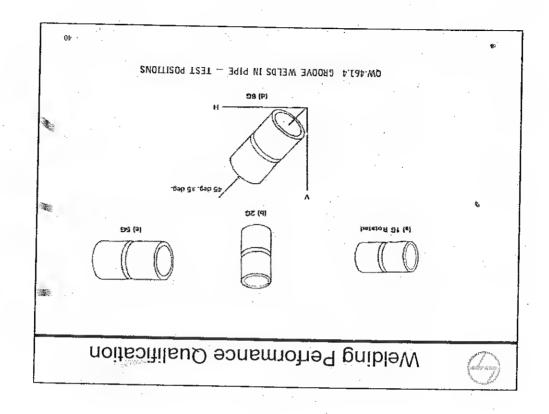
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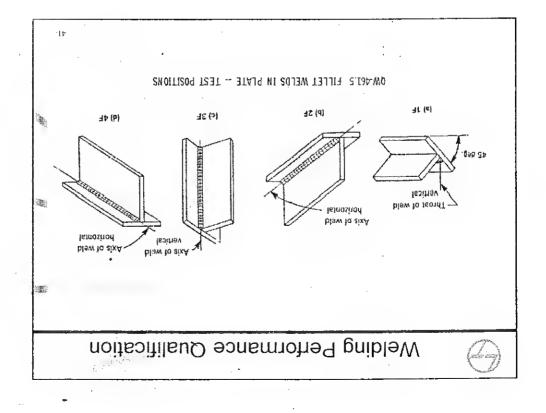
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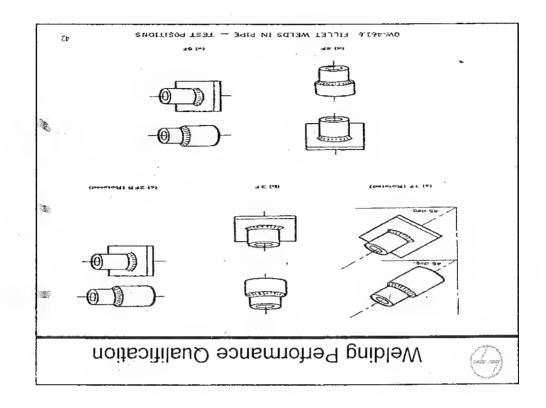


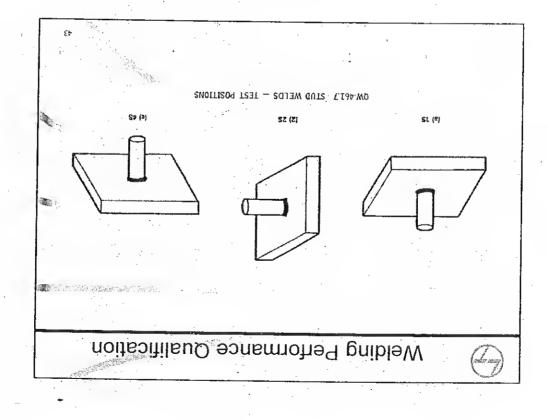












16 F F* H* F*H,V Plate 36 F,V F* F,H,O Stoove 46 F,O F* F*H* ALL Stoove 46 F,O F* F*H* Stoove 46 F,O F* Stoove 47 F,O F* Stoo	H, F ALL ALL ALL ALL SP&F	F,H F,V,O ALL ALL SP,F	F.H F,V,O ALL ALL SP,F	SG SG SG SAG Spot Spot Spot Spot Spot Spot Spot Spot	\$əqiq əvoonਹ
ədid +z iəvo	H,∃ V,H,∃ O,H,∃ ALL	*H8*7 *7 *3 *H8*4	F, H F,V F,O FLL	26 36 26, 36 &46 5pcl. Position	ajsiq evoolə
Qualitication Test Position Plate & Pipe Property Fillet Plate & Neble Weld Position Plate & Pipe Property Property		Pipe ≤ 24"		noitieo9	bləVV

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Performance Qualification Thickness Limits - QW 452.1(b)



Maximum To Be Welded	13 (1/2) and Over With Minimim Three Layers
1Z 12	IIA
Thickness of Weld metal Qualified	Thickness "t" of Weld mm in noquoon the Coupon in the Coupon in mm (in)

Performance Qualification



Groove-Weld, Pipe Dia. Limits QW 452.3

Notes:- 1) Type & Number of Tests as per QW-452 1 2) Welders Qualified on Groove, Are Also C Thickness & Any Pipe Dia	Jo spilied for making Fillets of	ynA no seziS lls
Over 73 (21/8")	73 (21/8")	bətimilnU
25 (1") to 73 (2%")	Se (1,,)	Unlimited
Less Than 25 (1")	Size Welded	Unlimited
(ni) mm ni noquoO	.niM	Max
Out Side Dia. Of Test	sid sbis tuo	. Qualified

Performance Qualification



Thickness limits & test specimen for Overlay

barimilan ar (ताम स्ट्रा मा (mm 25) .m (0 () thus (3) 25 roll basimilnu es bastilisup T batimiliau at ballilaup T 7 (mm &S) ni r nah asul Qualification Tessing Регіопавись (4) (1)' (8)' (10)' (6) (Nat 57) T the (25 mm) and byer T (UJU) SZ) TA (6) (ME '(5) '(b) STON r at au beitiliaup 1 basimilau os beililaup T ी (काला स्ट्री) जांच प्राप्तांग्रहे रहते । Procedure Qualification ype and Mumber of Tests Required Thickness of Test Coupon (T) Normanal Base Meial (T) Libore (2)) Correston-Reassal [Note (])]
Overlay RESISTANT OVERLAYS OW-REST PROCEDURENE FOR HERD FECTIVE CHESTS LIMITS AND TEST SPECINENS FOR FECTIVE SECTIVE THICKNESS LIMITS AND TEST SPECING THICKNESS LIMITS AND TEST SPECING THE SECTIVE SECT

How To Qualify A Welder



- 2) Train The Welder For The Process To Be Qualified
- Welder Shall Posses Adequate Skill in Performing the
- Remedy. Consumable, Defects In Welding, Their Causes And Machine, Precautions In Storage & Usage Of He Shall have Necessary Knowledge In Operation Of
- Which He Is To Be Tested / Qualified He Shall Practice Welding In The Particular Position In

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How To Qualify A Welder



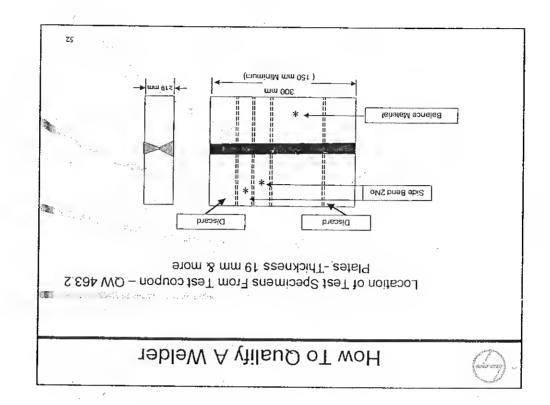
- 3) Preparation Of Test Coupon (Groove)
- Prepare A Test Coupon Out of 300 x 150 x 20 mm Plates Or Pipe Of 150mm long As Per Applicable WPS.
- WEP (Angle, Root Face & Root Opening) Shall Be As Per The WPS
- Provide Run in & Run Out Coupons on plate & Fix the Test Coupon in In Any One Of The Positions To Be Qualified
- Weld The Groove Fully In The Position
- All Welding Variables Shall be Strictly Within The Qualified WPS

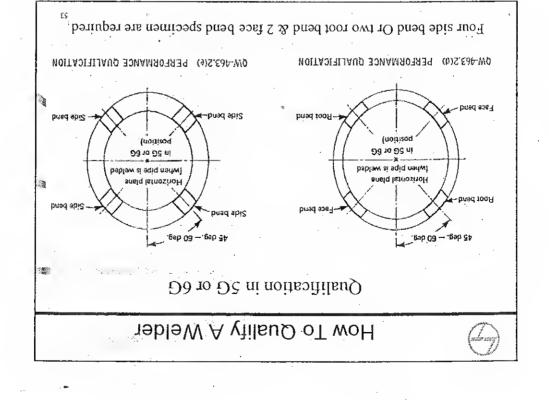
How To Qualify A Welder

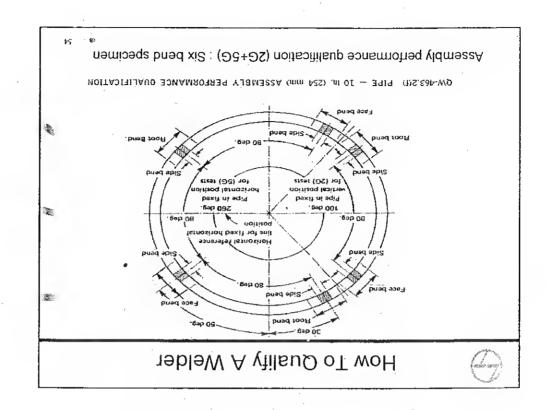


- 4) Type Of Test Required On Welded Coupon (Groove) (QW-302)
- Completed Coupon Shall be Subjected To Visual Inspection
 Inspection
- Mechanical Test QW 452.1
 For t <10 mm, Root Bend :-1 No, Face Bend :-1
 For t=10 to <19 mm, Side Bend :- 2 No or 1 RB & 1 FB
 For t ≥19 mm, Side Bend :- 2 No
 (For 5G \ 6G 2 Face & 2 Root Or 4 Side Bends)
 (For 5G \ 6G 2 Face & 2 Root Or 4 Side Bends)
 Alternate to Mechanical Tests, Radiograph the Coupo
- Alternate to Mechanical Tests, Radiograph the Coupon –
 Minimum Length

Location of Test Specimens From Test coupon – QW 463.2 Plates Less Than 19 mm Root Bert 110 Placerd Root Bert 110 Placerd Root Bert 110 Annual Discard Annual Discard







How To Qualify A Welder



5) Acceptability Criteria For Tests

Visual Examination – QW 302.4
 Free From Incomplete Fusion / Penetration and Surface

• Bend Test - QW 163

Opening not more than 3 mm in any direction on Convex Surface Within the Weld & HAZ

2.191.WD-TA •

No Crack, L/F & Incomplete Penetration No Slag, Cluster Of Porosity & Other Inclusions Beyond Specified Limit

WATER took was too states of chips house in sold (gold) and sold in some in sold of the bush of the board of the sold of the s

How To Qualify A Welder



• QW 191.2 Radiography Acceptance Criteria

QolonimaT 1.2.1e1-WQ

Linear Indication: L > 3W -Crack, LF, Slag

Rounded Indication : L <= 3W -Porosity & inclusions such as slag or tungsten

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How To Qualify A Welder



- QW-191.2.2 Acceptance standards
- Crack or LF (a) Following Linear Indications are unacceptable
- Elongated inclusion which has a length greater than
- 1). 3 mm for t up to 10 mm
- 2). 1/3 X f for t over 10 to 57 mm
- 3). 19 mm for t over 57 mm
- length of longest imperfection the successive imperfections exceeds 6L where L is > t in a length of 12t except when distance between Group of slag inclusions in line with aggregate length

How To Qualify A Welder

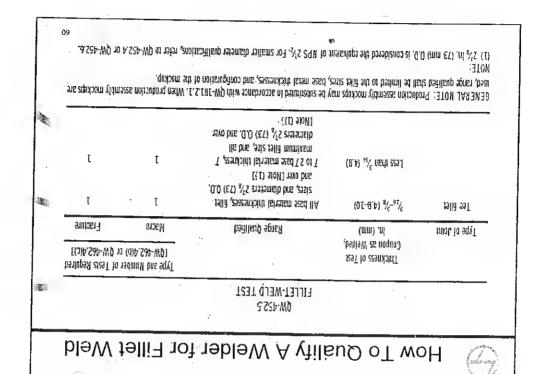


(b) Rounded Indication

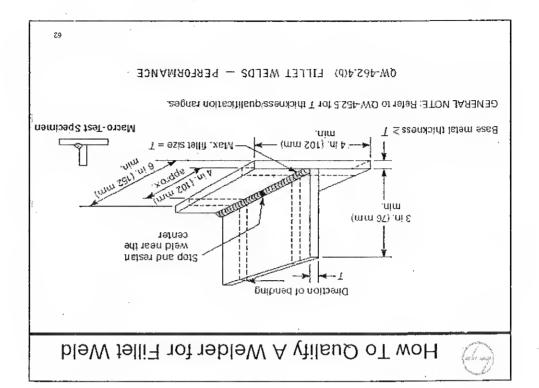
operators when T >= 3 mm

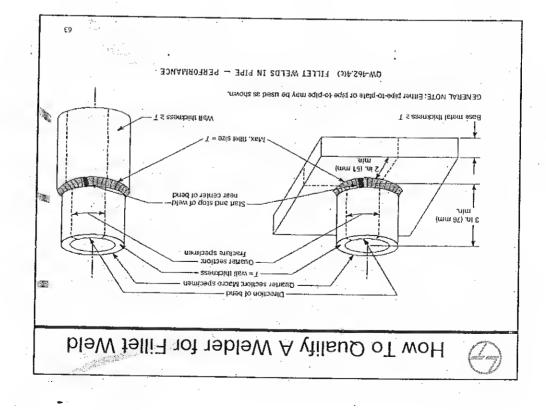
- be 20% of t or 3 mm whichever is smaller 1). Permissible dimensions for rounded indication shall
- 3). For welds in $T \ge 3$ mm, refer charts in Appendix I 150 mm are acceptable 2). For welds in $T \le 3$ mm,max. 12 no of indication in
- considered in the radiography acceptance test of welders & welding Rounded indications less than 0.8 mm in diameter shall not be

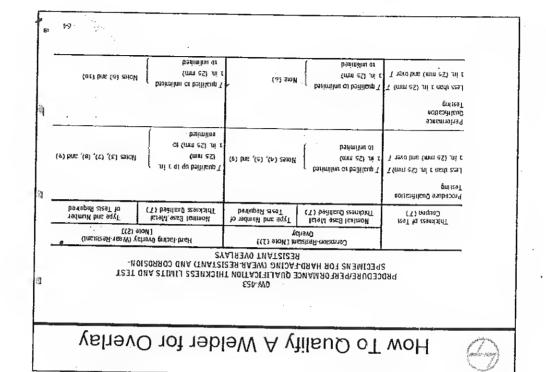
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	Rounded Indication Charts	77
	XIDN344A	(ada sag)



draffices on a groove weld test welder/welding operator suprawelb bine gaste raffa Anguig yaA Fillet welds are qualified when a All base material thicknesses, All thicknesses Takkness of Test Coupon as Welded, In. (mm) intot, to sayi Reculived Zype and Mumber of Tests FILLET QUALIFICATION BY GROOVE-WELD TESTS QW-452.6 (a) Type and number of tests required shall be in accordance with QW-452.5. (b) $2\frac{N}{N}$ in, (73 mm) 0.D, is considered the equivalent of NPS $2\frac{N}{N}$. GENERAL NOTES: (81) %2 Z/E (13) Bug ONEL (£1) % 2 ueut 2≥(o1 (2) £ ПА (SZ) [Size welded IIA (SZ) [UBU] SSP] paylleng (mm) 'ut 'payllsn) (पाता) जा Ourside Diameter of Test Coupon, Thickness. Minimum Outside Diameter SMALL DIAMETER FILLET-WELD TEST DW-452.4 How To Qualify A Welder for Fillet Weld







How To Qualify A Welder for Overlay

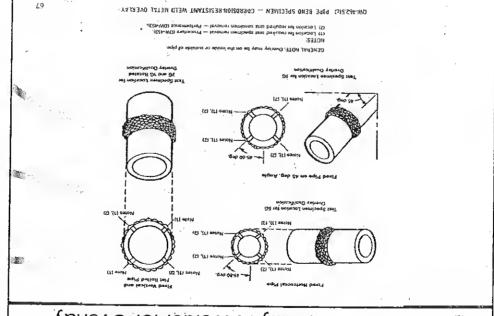


- TX021 X 021: noquoO to exi8 .
- WPQ on pipe: Length:150 mm MIN, & a min. diameter to allow the required number of test. specimen. Overlay shall be continuous around the circumference of the test coupon.
- Minimum width of overlay: 38 mm
- WPQ: for process where width of bead is > 13 mm, minimum three bead are required in first layer
- SB specimens are perpendicular to the direction of welding in accordance with QW161. Locations specified in QW-462.5(b) or QW-462.5(d)

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How To Qualify A Welder for Overlay





OW-322 Expiration & Renewal Of Gundustrian



- QW-322.1 Expiration of Qualification
- When welder Or welding operator has not welded with a process during a period of 6 months or more, his qualification for that process shall expires
- When there is a specific reason to question welder or welding operator's ability to make welds that meet the specification, the qualification that support the welding he is doing shall be revoked.

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QW-322 Expiration & Renewal Of Owner of the Computation Output Out



• QW-322.1 Expiration of Qualification

GW-30S

- Re-qualifications have been revoked.
- Renewal of qualification expired under expired under QW-322.1(a) may be made for any process by welding a single test coupon of either plate or pipe, of any material, thickness or diameter, in any position & by testing of that coupon as required by QW-301 &
- Work (QW-322.1 (a))

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A Presentation

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PSME SECION IX - WPS / PQR

By: Hemal Desai

YZWE SECTION IX



> Qualification standards for Welding & Brazing Procedures, Welders, Brazers, & Welding & Brazing Operators.

ASME SECTION IX



- Divides into Two Parts:
- Part QW- Welding
- Part QB- Brazing

Part QW - Welding

Article I – Welding General Requirements Article II – Welding Procedure Qualification Article III – Welding Performance Qualification Article IV – Welding Data

Welding Qualifications



- · Welding Procedure Qualification
- Welders' or Welding Operators' Performance

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MPS & PQR



Purpose:

To determine that the weldment proposed for construction is capable of having the required properties.

WPS: Welding Procedure Specification

PQR: Procedure Qualification Record

MPS



VVPS:A written qualified welding procedure prepared to provide direction for making production welds to code
 requirement

- Contents of WPS: Essential, Non Essential, and, when required Supplementary essential variables for each welding process used in WPS.
- Changes to the WPS: May be made in non essential variables to suit production requirements without requireding.
- Availability of the WPS:WPS used for code production welding shall be available for reference & review by AI at fabrication site.

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Welding Procedure Qualification



• WELDING DATA

A set of Welding Variables involved in Preparing a Weld Joint.

• ESSENTIAL VARIABLE

A change in welding condition which will affect the mechanical properties (Other than notch toughness) of weld joint

• SUPPLEMENTARY ESSENTIAL VARIABLE

A change in welding condition which will affect the notch toughness properties of weld joint المعربة المربة المرب

A Change in welding condition which will not affect the mechanical properties of the weld joint

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PQR



- PQR A record of the welding data used to weld a test coupon. Also contain test result of the tested specimen.
 Content of the PQR: PQR shall document all essential.
- Changes to PQR: Changes to PQR are permitted except Changes to PQR: Changes to PQR are permitted except
- Editorial Correction
- AD9 edit of sbnebbA -
- Additional information can be incorporated in PQR at a later date provided the information is sustained as having been the part of the original qualification condition by lab record or similar data
- Availability of PQR:PQR shall be available upon request for review by ALPQR need not be available to the welder or welding operator.

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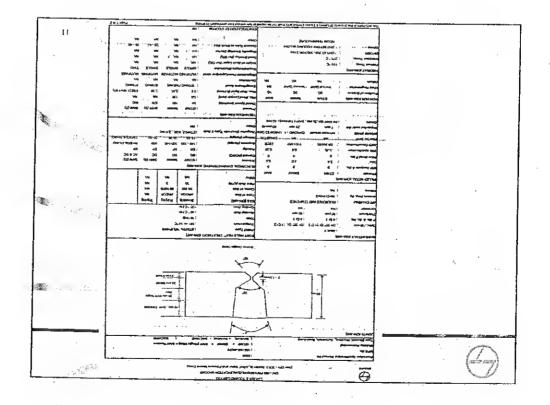
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MPS & PQR



- Multiple WPSs with One PQR / Multiple PQRS With One
- Several WPS may be prepared from the data on a single PQR
- Single WPS may cover several essential variable changes as long as a supporting PQR exist for each essential variable &, when required, supplementary essential variable

Welding Procedure Qualification



- Proves the Quality / Properties of Weld Joint
 Prepared by a set of welding variables
- Welding Process
- Base Material
- Welding consumable
- Welding Parameters & Techniques (Position, Polarity, Preheat, Inter Pass Temp.)
- PWHT etc.
- Qualification limited to the essential variables of the Specific Process



- Reduirements Understand ASME Sec. IX Classifications &
- Welding Data Essential, Non Essential & Supplementary Essential Variables. QW-251, 400
- QW-420 & 422 - Parent Metal Grouping - "P" No / S No; Group No -
- Filler Metal Grouping "F" No QW-431,432, 433
- 440, 441, 442 Weld Metal Composition Grouping - "A" No - QW-
- Welding Positions, Groove & Fillet QW-461

How To Qualify Groove Butt Weld Procedure?

- Guided Bend, Nojch Toughness QW-141, 451, 153, 163, 171, 172, 462 Types of Tests & Acceptance Limits – Tension
- Test Requirements QW-451
- Test Specimen Location, Dimension & Testing Procedure QW- 462,463,464,466
- Qualifications Range in Thickness QW-451
- Record & Documentation of WPS, PQR

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QW-253 Welding Variables Procedure Specification(WPS)

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Dept page bod blow song LAD & EERS Thickness

QW-403.5

- WPS shall be qualified using one of the following
- Same B.M. to be used in production welding
- B.M. listed in the same P-Number group no in QW-42S as the B.M. to be used in production welding
- When B.M. of different P-Number group number combinations are qualified using a single test coupon, that coupon qualifies the welding of those two P-Number Group number to them selves as well as to P-Number using the variable qualified.

0.604-WQ

- Minimum B.M. thickness qualified is: T or 16 mm whichever is less
- When T < 6 mm, Minimum thickness qualified is 1/2T

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3 404-WO 8 4 404-WO



- A change from one F-Number in QW-432 to any other F-Number or to any other filler metal not listed in table QW-432.
- Change fro one A-Number to any other A-Number in table QW-442
- Qualification with A-No 1 shall qualify for A-No.2 & vice versa.

QW-405.2



- brogression

A change from any position to the vertical uphill

- · Vertical uphill progression shall qualifies for all position
- In uphill progression, a change from stringer bead to weave bead.

6.304 WD & 1.304-WD

据各级数据 网络迪斯里斯斯人 电扩充电流



- · QW-4061
- Decrease of more than 55° C in the preheat temperature dualified Minimum temperature of welding shall be specified in WPS.
- £.804-WQ •
- Increase of more than 55° C in in the maximum interpass temperature recorded on the PQR

2.704-WO



 Procedure qualification test shall be subjected to PWHT essentially equivalent to that encountered in the fabrication of production weld, including at least the fabrication of production weld, including at least the aggregate times at temperature

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6.

(E)

1.604-WO



- Increase in heat input, or an increase in volume of weld metal deposited per unit length of weld, over that qualified.
- Heat Input = Voltage X Amperage X 60

 Travel Speed (in./min(mm/min.))
- Volume of weld metal measured by :
- 1 Increase in bead size(W X T)

 2 Decrease in length of weld bead per unit

length of electrode.

Eliz onzy

 QW-255
 Welding Variables Procedure Specification(WPS)

GMAW & FCAW

The T < 13 then man qualified thickness will be 1.17

Change in P-No SA to PNO SB cm SC is establish revisible.

	€.	Increase > 100°F (56°C) (1P)		, × ,	
169Ho	ž.	் Preheat malm.			×
906-7	Į.	DECKESSE > 100°F (56°C)	×		
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	II.	± Retainers			×
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	⊊T.	♠ Ejectrode spacing			×
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	9.	w Merpog pack donde			×
	ς.	φ Wethod cleaning			×
	٤.	& Orlfice, cup, or nozzle size			×
	-	aveaveave			×
·	8	Φ & E range			×
Characteristics	b.	◆ Current or polarity		×	x
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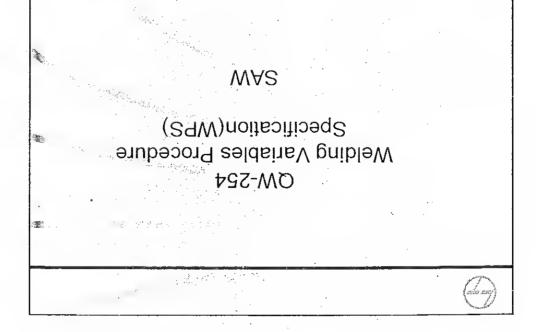
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216191	.s.	& Y Qualified	×		
9950 GW-403		7.7 Limits > 8 in. (20.3 inm)	×		
	9.	SHW17 2	^	×	
	S	A Group Mumber		×	
	11	# Retainers		^	×
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204-VV		- Backing			×
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Jechnique 3W-410	8.				Χ
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	9,	🏘 Wethod back golige			Χ
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	SI.	φ	Electrode spacing			х
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QW-410 Technique	6.	φ	Multi to single pass/side		X	X
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	ē.	φ	Orifice, cup, or nozzie size			Х
	I.	φ	StringAweave		_	X.
	ZI	ф	Tungsten electrode			X
รวมระบอเจนเลย	8.	φ	. § E range	-		Χ.
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P – Number Grouping (Base Metal For Qualification)



	Met. Quálity & Form	Grade	Met. Spec.	Group ON	-WO
	CS - Plate	0 <u>/</u> 09	313 A2 \ 313 A2 313 A2 \ 313 A2	۲ . ا	ld
	C2 - Pipe	C V'B	901 A2 901 A2	2	ld
	CS - Pipe	01. 9	EEEAS EEE AS	3	ŀd
	CS Pipe Fitting CS Pipe Fitting	MbC MbB	AES AS AES AS	2 .	И
	C2 blate	C/B	385 A2	l.	ld
ı	CS Tube		.621 A2	ı	ld
	CS Forging CS Couging	CI 10	201 A2 181 A2	2	ld

P – Number Grouping (Base Metal For Qualification)



	Met. Quality & Form	9bs10	Met. Spec.	Group No	oN -q
	Mn – 0.5 Mo – Plate	A	S08 A8	Z	٤٩
	91sl9 - 0M 2.0 - mM	B,C,D	S0£ AS	3	
	C - 0 5 Mo - Pipe	Zd/1d	388 A2	l	£q
	C - 0.5 Mo - Plate	TP-8, CL-1 or 2	SA 533	ε	£4
289	C - 0.5 Mo - Tube	dfT,sfT,fT	8A 209	Ŀ	દવ
	C - 0.5 Mo - Forging	13	S82 A2	2	ь3

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P – Number Grouping (Base Metal For Qualification)



-	<u> </u>			1	
	1.25 Ct - 0.5 Mo - Forging	F11, CI-1/2/3	. 8££ A2		
	1. Ct – 0.5 Mo – Forging	E12, CL 172	S82 A2	٠ ٢	⊅d
	1.25 Cr. 0.5 Mo - Tube	. 2/1-qT	ESA A2	Z	7d
	Pipe and a	• • •			
	1Cr (1.25 Cr) - 0.5 Mo -	।।व/ राव	38£ AS	1	ta.
	1.25 Cr. 0.5 Mo - Plate	11, CI-172	78£ A2	ε	
1	1Cr. 0.5 Mo – Plate	12, CI-112	78£ A2	↓ ·	⊅d
	Met. Quality & Form	Grade	Met. Spec.	Group oN	oN -⊂

P – Number Grouping (Base Metal For Qualification)



	Met. Quality & Form	Grade	Met. Spec.	Group ON	0N -c
\parallel	2, 25 Cr. 1 Mo – Plate	22, CI –1 /2	78£ A2	l.	A ∂9
	5 Ct. 0.5 Mo - Plates	2' CI-5	78£ A2	· l	894
	2.25 Cr. 1 Mo - Pipe	P22	38£ A2	ı	A∂q
	225 Cr. 1 Mo - Tube	22 - 9T	SIS A2	ı	A∂q
	5 Ct - 0.5 Mo - Forging	F-5	S81 A2	. 1	889
60	2.25 Cr - 1 Mo,V - Forgi	F22V	S81 A2	Į.	P5C
	2. 25 Ct - 1 Mo - Forging	F22, CI-1 / 3	988 AS	į.	Aaq



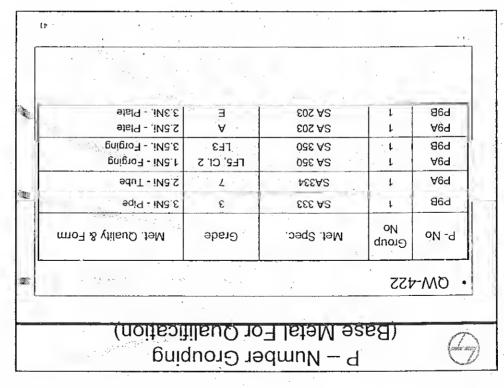
	e destable de la		7-10	Group	. 514 6
	Met. Quality & Form	Grade	Met: Spec.	oN	. ON -c
	15Cr Plate	624 9T	042 A2	2	94
	13Ct., 4.5 Ni, Mo - Pipe	241500	157 AZ	· Þ	9d
	13Cr. – Tube	TP410	892 A2	ı	9d
	13Gr.—Forging	9-1	988 A2	3	9d
	17Cr Forging	F430	S81A2	5.	. Zd
	17Cr - Plate	7. 0£4 gT	042 A2	z	Zd
٢	17Cr. Tube		997 VS	-2	<u></u>
	18Cr., Ti-Pipe		1ET AS	2	Ld

P – Number Grouping (Base Metal For Qualification)



	18Cr, 13Ni, 3Mo - Tube 16Cr, 12Ni, 2Mo - Tube	7159T J3159T	642 A2	L	89
1	18Cr, 8Ni - Plates 23Cr, 12Cr - Plates	▶0£9T 260£9T	042 A2	2	84
	18Cr., 8 Ni, 2Mo -Forging 25Cr., 20 Ni, Forging	8159T 0159T	988 AS	Į Į	84
S. S.	18Cr., 10Ni, Ti - Pipe 18Cr., 10Ni, Cb - Pipe	12897 74897	Ste Ag Ste Ag	l l	84
	Met. Quality & Form	Grade	Met. Spec.	Group	oN-d

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9), O.75Ni - Plate	Ma, 0.5 Mc	TP C, Cl. 3	553 A2	Þ	Attq
. 0.5Ni – Plate	oM 8.0 ,nM	TP B, Cl. 3	££3 A2	· Þ	Attq
Cr0.5Mo V, Forging	37.1-IN3.8	2' Cl' 5	803 A2	g	Atta
Cr0.5Mo V, Forging	37.1- INB.E	4M, CL 2	803 A2	g	Attq
	eduT - iMe	8	\$£5A2	ţ	Arrq
	əqiq - iNe	8	EEE AS	ţ	Attq
Quality & Form	.təM	ebera	Met. Spec.	Group .	oN -¤
				771	-W0
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Welding Procedure Qualification

Material Grouping(P-Numbers)

	gaiseiA	gaible W	EstaM ass8
	Р-Ио. 101 through Р-Ио. 103	P-No. 1 through P- No. 11 incl. P- No. 5A, 5B, and	Steel and steel avoils
	-4 bre +01 ,oV-4	5С Р-Йо, 21 through	-uts bas munitallA
	701 .0V	P-No. 25	alloys
	.oM-9 bas 701.oM-9	P-No. 31 through	Copper and cop-
1.0	108	P-No. 35	per-base alloys
	figuranti 011 ovi-fi	P-No. 41 through	Mickel and nickel-
-	P-No. 112	Lt 'ON-d	pase alloys
	P-No. 115	P-No. 51 through	-stit bas mutasti l
	•	FC .0N-9	ayotta əsad-muin
	P-No. 117	P-No. 61 through	-tix bas multioptiX:
1		59 '0N-4	oseq-umiuoo
€17	±*		skope



Welding Procedure Qualification

QW-424

or redmuyl-q s mort feter set of smes pt. The set of th Base Metals Qualified Combon Procedure Qualification rot beaU (a)feretA eastH

One metal from P-No. 3 to any Jaquinsi Number One metal from a P-Number to any metal from any other P-Number to Sumpley the property of the property

E. .0N-9 moral from P. No. 4 to any One or 4 .0N-9 moral from P. No. 4 or Az .0N-9 moral from P. No. 50N-9 moral from P. No. 5

oth or letter barglessent to An Instant to the Instant banglessent arms. One metal from P-No. 5.A to a O-No. 5.A to to p-No. 4 to to p-No. 1 a to p-No. 4 to a One metal from P-No. 5 to p-No. 1 to p-No. 1

Mumber metal to any P-

Any unassigned metal to any

Any metals assigned that P-

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Any P-No. 5. motal to any factor and to any factor and to any p-No. 5. or p-No. 1. or p-No. 1. or p-No. 1. or p-No. 1. or p-No. 2. or p-No. 1. For P-No. 4 metal to any metal of the P-No. 4 3, or 1
from P-No. 5.A metal to any metal from P-No. 2.A. solution and metal from P-No. 2.4, 3.

Incertain metals. A metal assigned the first P. Number to any metal assigned the second P-Number (a.M. T. P.No.) 3 or P-No. I of metal to any metal P-No. 3 or P-No. 1 van P-No. 2 or P-No.

of larse threasigned threat the form the second moral The unassigned metal to any unced assigned to the same P-The unassigned metal to fixelf

	ពលវា	Important F-NUMBERS Crouping of Electrodes and Welding Rods for Qualification		· · · · · · · · · · · · · · · · · · ·
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****	EXXIS	SFA-5.1		4
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	EXX18	SFA-5.1		4
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	EXX48	CFA-3.1		ъ ф
	EXXX(X)-12	xelqub bas sustentities and 4.2-4.72		Þ
	EXXX(X)-19	SFA-5.4 other than austenitic and duplex		ħ
	EXXX(X)-13	xalqub bns attinstaus neft radio 4.2-472		t
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	EXXX(X) II	xalqub bns aldinavus A. 2-A.78	ç	
E.		6₩ -4 35		
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	notised SWA	notissidisiq2 3fd2A	E-NO.	
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	ENICHE-3 ENICHEE-4		5b	
	EMICYF6-9	11.2-448	٤٤	
	0.E- 3 910IW.3	I I. è-A 72	र्षः	
	E MICLWO-S	££.8-A∃8	٤٤	
	E MIC1410-3	11.8-A78	43	
	E NICTMO-6	[L.č-A-12	43	
	E MOLWO-75	I (.e-A48	٤5	

Welding Procedure Qualification



	I(I) 910N1 % , ziżyściA							
IS	ugg	!N	oM	13	2	Types of Weid Deposit	,0M·/	
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σ.τ	09 T	• • • •	64.0-0⊅.0	06.0	21.0	Carbon-Molybdenum		
	97 L		29.0-04.0	00.5-04.0	615	Clinome (6,4% to 2%)+Molybdenum		
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How To Qualify Groove Butt Weld Procedure?



2) Understand ASME Sec. II Part C.

- Specification for Filler Analysis SFA No
- AWS Classification of Welding Consumable
- Limits for Chemical Composition & Mechanical Properties of Consumables



- 3) Write A Welding Procedure Specification WPS
- WPS Provides Direction for A Specific Welding
- WPS Shall Include All Essential, Supplementary Essential & Non Essential Variables
- WPS Format Available in ASME Sec. IX:
- Each WPS Shall be Assigned with A Unique Number

How To Qualify Groove Butt Weld Procedure?



- t) Prepare A Test Coupon As Per WPS
- Coupon Size: 500 mm X 150 mm X T
- All Other Details as per Written WPS

 Complete the Welding by Reasonably Skilled Welder
- Specified in WPS.
- All Variables Actually Used Shall be Documented as Annexure to PQR (Procedure Qualification Record)



- 5) NDT Of Weld Coupon Optional
- Reduirement) X-Ray \ Radiograph the Weld Joint (Not a Code
- QW463 Mark Transverse Tensile & Guided Bends As Per
- the Test Specimens Eliminate Defective Weld Portion If Any, While Marking
- Preserve RT Report & X-Ray Film as Annexure to PQR



How To Qualify Groove Butt Weld Procedure?

6) Mechanical Tests

Test Specimen - QW-451 Procedure Qualification Thickness Limits &

(3)

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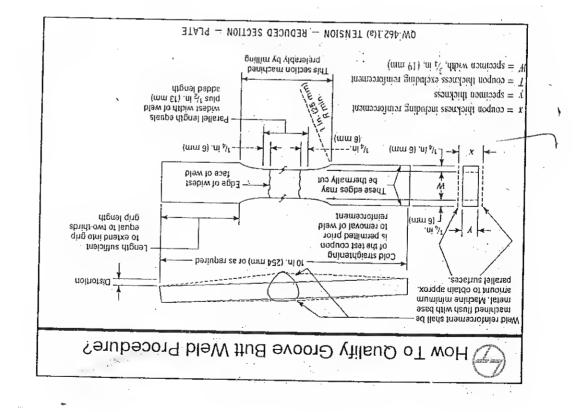
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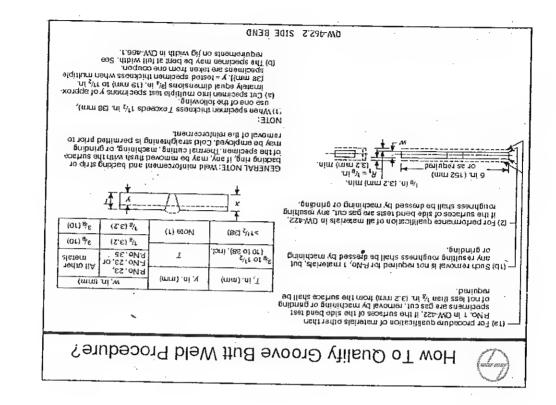
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QW-463.1(b) PLATES — ¾ In. (19 mm) AND OVER THICKNESS AND ALTERNATE FROM ¾ In. (10 mm) BUT LESS THAN ¾ In. (19 mm) THICKNESS PROCEDURE QUALIFICATION ●

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QW-463.1(3) PLATES — LESS THAN ¾ In. (19 mm) THICKNESS PROCEDURE QUALIFICATION





How To Qualify Groove Buff Weld Procedure? 6 in, (152 mm) or Re 1/2 in, (38 mm) Face-Bend Specimen — Plate and Plpe Face-Bend Specimen — Plate and Plpe Root-Bend Specimen — Plate and Plpe Root-Bend Specimen — Plate and Plpe A 1/2 in, (38 mm) Root-Bend Specimen — Plate and Plpe N. In. (mm) Or P-No. 23, F-No. 23, Metals T 1/2 in, (3.2) in other Or P-No. 35, Metals T 1/3 in, (3.2) in other Or P-No. 35, Metals T 1/4 in, (3.2) in other T 1/4 in, (3.2) in other T 1/4 in, (3.2) in other T 1/4 in, (mm) Or P-No. 35, Metals T 1/4 in, (3.2) in in,

How To Qualify Groove Butt Weld Procedure?



7) Acceptance Criteria for Test Results. QW-153 Acceptance Criteria - Tension Tests Specimen shall have Tensile strength that is not less than:

- Min. specified T.S. of base metal
- Min. specified T.S. of weaker of the two, if base metal of different min. T.S. are used. Min. specified T.S. of weld metal when applicable
- when the applicable section provides for the use of weld metal having lower room temp, strength than base metal.
- If specimen breaks in the B.M. out side of the weld or weld interface, the test shall be accepted as meeting the requirements, provided the strength is not more than 5% below the minimum specified T.S. of the base metal





QW-163 Acceptance Criteria - Bend Tests

Guided bend test specimens shall have no open discontinuity in the weld or HAZ exceeding 3 mm, measured in any direction on the convex surface of the specimen after bending

How To Qualify Groove Butt Weld Procedure?



- 8) PQR Procedure Qualification Record
- PQR Format Available in Sec. IX
- Record All Relevant Data in the Format.
- Record All Mechanical Test Results
- Attach All Test Reports & Welding Parameters Used as Annexure to PQR
- Assign Unique Number to Each PQR
- WPS No Shall be Referred in PQR

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- A WPS Remains Qualified When
- A Procedure Qualification Coupon Is Welded As Per
- All Mechanical Tests of The Coupon Are Completed All Test Results Are Within The Acceptable Limit
- The Supporting PQR No Is Referred In The WPS

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